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The Status of Renewable and Sustainable Energy and How They Apply to Electric Vehicle Recharge Stations

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Research Article

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Abstract: Over the last 20 years, significant advancements have been achieved in the area of sustainable and renewable energy. The solutions to pollution, deforestation, global warming, and climate change were made possible by sustainability and decarbonization. The requirement for electricity may be met in a number of ways by using sustainable storage, dependable supply depending on demand, and environmentally acceptable energy sources. Electric vehicles (EVs) are becoming more and more popular as a future form of transportation. The most recent renewable energy sources are defined and examined in this essay. These are either whole new technologies or specialized or improved versions of traditional energy sources including hydro, biomass, biofuels, geothermal, wind, and solar. These technologies include cellulosic ethanol, enhanced geothermal energy (EGE), concentrated solar photovoltaics (CSP), marine energy, and artificial photosynthesis. The description of each new renewable energy source is followed by information on its market share, difficulties, potential for further adoption, and disadvantages. Additionally, as an application of renewable energy, integrated photovoltaics and wind-powered electric vehicle charging stations were created. Electric cars may get an adequate amount of electricity throughout the day thanks to the electric charging station's efficient design. In addition to laying the groundwork for future study in EVs and related topics, this report offers general research information on developing renewable resources.

Keywords: Renewable energy, sustainable energy, charging stations, electric vehicles, marine energy, and photovoltaics are all viable energy sources.

Introduction

All nations' economic development depends on the production and use of energy [36]. Nowadays, energy is needed for most tasks. Examples include transportation, industry, housing, agriculture, air conditioning, and health. By 2035, there will be two billion cars in the globe [33]. Coal, oil, and natural gas are examples of fossil fuels that are now in great demand [1]. Carbon emissions are affected when these resources are burned. Increased greenhouse gas emissions result in pollution, climate change, an increase in global temperatures, health hazards for people, animals, and plants, and an increase in sea levels. Globally, there are several studies, regulations, and strategies for lowering CO2. Nevertheless, fossil fuels are still necessary and cannot be replenished. Therefore, switching to renewable resources is the only way to meet future requirements. Additionally, this aids in lowering greenhouse gas emissions. Renewable resources are timely, dependable, and economical.

supplies [8,9]. This approach aids in the adoption of a sustainable development plan, which meets present-day needs without endangering those of future generations.

Major pollutants are released into the atmosphere by the current transportation system [29]. EVs have been used in recent years to lessen air pollution and the transportation sector's reliance on oil. Fuel cells and batteries are used by EVs to store energy. They don't rely on fossil fuels. There won't be any gas emissions from the automobiles [30]. Since 2009, China has had the highest EV sales, reaching 2.08 million in 2018 [34]. However, a number of issues, including the cost of the battery, the grid, and charging techniques, must be addressed in order to make EVs stand out in

the market [31]. It is noteworthy that there was a dearth of real-world data about EVs, including new technology and regulatory scenarios [35]. A gasoline car uses 12 cents per mile, but an electric vehicle uses only 2 cents [32]. Owning an electric car allows people to save time at petrol stations by charging their automobiles at home or at an EV charging station. As a result, this difficulty inspired us to look for practical solutions for energy generation and administration.
The manuscript's primary goal is
Examine different renewable resources according to their market share, difficulties, potential for greater acceptance, and disadvantages.
The installation of an EV charging station using wind and solar power.
Evaluation of the efficiency and investment in renewable and non-renewable resources.
An overview of the most recent renewable energy sources, including ocean power, wave and tidal energy, concentrated solar power/photovoltaics, EGS, cellulosic ethanol, and artificial photosynthesis, was covered in this paper. The process with current technology, future scope, market shares, scope, and challenges of each renewable energy source were discussed. In order to supply automobiles and other vehicles with a sustainable energy source throughout the day, it also emphasizes the installation of an electric charging station using solar/photovoltaics and wind energy. To aid future development researchers, the advantages and disadvantages were also discussed.
This paper is arranged as follows: The literature study is given in Section 2, and the growth of sustainable and renewable energy is shown in Section 3. Section 4 provides an explanation of the latest sustainable and renewable energy technology. The use of solar and wind energy to power EVs is covered in Section 5. The benefits and drawbacks are shown in Section 6, the results and discussion are presented in Section 7, the comparison of investment and efficiency for renewable and non-renewable resources is explained in Section 8, and the study is concluded with future work in Section 7.

Literature Review

A multicriteria approach for scheduling a hybrid electric car charging station was put into practice in 2020 by Petrusic et al. [23]. At first, it maximized the utilization of solar power plants and tracked the source of energy. An energy storage system and a public distribution network for solar power plants were linked to the EV charging infrastructure. The outcome shown that the car may be charged in many ways based on the availability of energy from various sources, including the battery, PV panels, and network.
Noman et al. [24] used an interval-based method for converting wind energy in 2020. The method was first examined utilizing a variety of limitations and standards, such as standard high-resolution wind speed datasets, different turbine manufacturers, and wind speed averaging time intervals. The efficacy of EV charging was measured using the output energy of a quasi-continuous wind turbine. Lastly, the viability of direct wind-to-EV charging was assessed using two years' worth of wind speed data in the Performance of the Wind Turbine research.
Sakib et al. [25] used Matlab/Simulink to do mathematical modeling and simulation for a microgrid system with natural gas generators and an electric car charging station in 2017. First, the natural gas generators' excitation systems, grid-tied operation, off-grid operation, and combined heat and power production were all simulated. Electric vehicle charging station levels, DC bus capacitance estimates, EV batteries, battery chargers, three-phase inverters, and LCL filters are all included

in this simulation. Ultimately, the outcomes of the simulation were examined and confirmed.

PLEXOS was created in 2013 by Foley et al. [26] to examine the effects of charging electric vehicles. In order to dispatch electricity to meet demand as a series of models, first input data on market and operational restrictions from the generating portfolio. Then, using deterministic or stochastic programming techniques, solutions were developed to minimize an objective function or expected value subject to a number of constraints, such as the cost of electricity dispatch, the availability and operational characteristics of generating plants, licensing environmental limits, fuel costs, and operator and transmission constraints. Ultimately, the findings demonstrated that off-peak charging was superior than peak charging.

Microbial fuel cells were used by Abas et al. [27] in 2020 to produce hydrogen. This process produced clean, renewable energy by splitting water molecules into hydrogen and oxygen using sunshine. This mechanism stores sun energy in the carbohydrates' molecular bonds.

Sayed et al. [37] presented an integrated DC microgrid using wind and solar energy in 2019. first incorporating solar PV panels and a wind turbine into the DC microgrid. The power supply load was controlled via DC converters and inverters. The extra power was stored in the battery and utilized as required. The outcome shown that this technique can provide power all day long.

Aboelezz et al. [38] developed a wind turbine-based general electric car battery charging system in 2023. An ANN model was constructed using a tiny vertical-axis wind turbine. The charging performance was then predicted by inserting it into the MATLAB/Simulink software package. To maximize the power produced by the wind turbine throughout the day at different wind speeds, a rpm controller was used. The constant current constant voltage (CC-CV) charging protocol was then implemented by feeding it into an EV battery charger. Despite variations in the electricity produced by the utility grid or wind turbine, the charging current remains constant. The outcome shown that using wind energy to power EVs produces enough steady electricity that is supported by the utility system.

Karmaker et al. [39] combined solar and biogas to provide energy in electric vehicles in 2023. Additionally, it used the GA-PSO method, PSO, and GA for optimization and improved outcomes. Additionally, the procedure was assessed and the results were contrasted with current flat-rate tariffs. The findings demonstrated a 74.67% reduction in energy expenses when compared to the current flat rate tariffs, as well as lower charging prices on weekdays and weekends.

Review

The methods, benefits, and drawbacks of the current approach are shown in Table 1. Eight studies that used diverse approaches at different levels were taken into consideration. The advantages and disadvantages of each approach were thoroughly discussed.

Table 1: Review Based on Existing Methods

Author	Methodology	Advantage	Disadvantage
Petrusic et	Multicriteria optimization	Maximized the use of renewable sources.	Required significant investment in

al. [23]		Flexibility in charging. Easy to implement.	infrastructure, such as solar power plants and energy storage systems.
Noma et al. [24]	Interval-based approach	Cost Effective method. Reduced greenhouse gas emissions and promote sustainable transportation. Provided a constant power supply for specific time intervals. Suitable for urban areas with high demand for EV charging.	Feasibility depends on several factors. Required significant investment in wind turbines and other infrastructure.
Sakib et al. [25]	Matlab/Simulink	Reduced the negative impact on the environment and geological aspects. Meet the demand for the next-generation power system. Depends on the availability and accessibility of natural gas resources. Better design and optimization of the system. Enhancing fuel efficiency.	Required initial investment and infrastructure development.
Foley et al. [26]	PLEXOS	Minimize the cost of electricity dispatch and to some constraints. More accurate analysis of the impact of electric vehicle charging under peak and off-peak charging scenarios.	May not be directly applicable for other electricity markets.
Abas et al. [27]	Microbial Fuel Cell	Developed more efficient and stable water-splitting systems. A promising technology for generating clean and renewable energy. Can withstand harsh conditions and resist corrosion.	Used expensive catalysts. Need for large areas of land and the requirement for continuous monitoring and maintenance.
Sayed et al. [37]	DC microgrid	Reduced carbon emission Provide sufficient electricity supply.	Costly and may require a significant initial investment.
Aboelezz et al. [38]	Generic electric vehicle charging and ANN battery system	Accurate and efficient model. Achieved the maximum generated power from the wind turbine across the day.	Required a full prediction of the wind signature. Required initial investment in wind turbines and charging infrastructure.
Karmaker et al. [39]	Fuzzy inference system	Reduced energy costs Provided lower charging costs Establish a sustainable charging infrastructure Effective energy management	Effectiveness may vary with sizes and locations. Required initial investment costs.

system.

Challenges

The following are a few problems that EVs encounter:

It is simple to apply in [23][24][25][37][38][39]. However, it required a large infrastructure investment, including energy storage systems and solar power plants. The project's individual implementation is dangerous for commercial usage. The generation of renewable energy is maximized by solar and geothermal energy [23][27]. As a result, a lot of room was needed for the solar panel configuration and the artificial EGS. Resources and climate have an impact on energy generation [24, 25]. For instance, solar energy is at its peak throughout the day on bright days, and the production of energy is also greater in areas with an abundance of natural resources. The industrial plants needed storage facilities to store the extra energy. Nevertheless, the energy source is far distant from the complicated storage facilities. The approach offers reduced energy expenses in [39]. It also relies on available resources. Higher resources result in cheaper prices, and vice versa. The most abundant renewable sustainable energy sources are wind, tidal, and geothermal energy [24, 37, 28]. Birds, fish, and other living things are impacted by pollution from a variety of sources, including carbon emissions from transportation of machinery and setup, urbanization of surrounding areas due to a lack of labor for the plant, clearing the areas by removing the habitual inhabitants, noise pollution from turbines, and tidal plants. As a result, there are fewer EV charging points.

Renewable and Sustainable Energy Development

To get a sustainable energy source, it must meet certain social, environmental, and economic criteria. An overview of established and emergent renewable technologies is explained in Fig. 1,

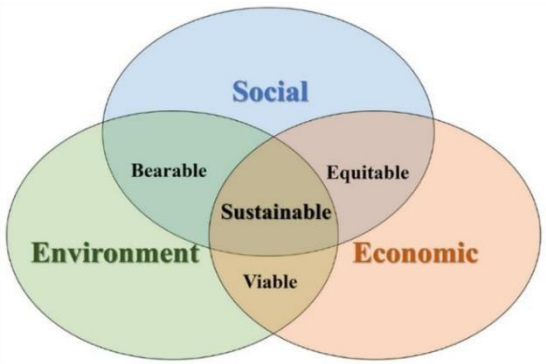


Fig. 1. Sustainable Development Scheme (Source: Sustainable Development Portal)

Today, renewable energies are more mature and dependable on the rise and increasingly competitive with conventional energy sources. Bio-energy, Wind power, geothermal power, heat, hydro power, Solar PV, CSP, Solar thermal heating and cooling, and Ocean power are on the right track, and in some cases have surpassed economic

limitations. The proportion of renewable energy sources in global final energy consumption is increasing.

In 2014, renewable energy was estimated to account for 23.7% of global final energy consumption [2], and by the end of 2019, it is 27.7% [3]. Fig. 2 depicts the contribution of various renewable energy sources to the world's renewable energy. It has been observed that hydropower accounts for 15.9% of the total 27.3% of renewable energy sources, while wind power, solar PV, and bio-power account for 5.9%, 2.8%, and 2.2% respectively. As shown in Fig. 2, other renewable energy sources such as geothermal, CSP, and ocean power contribute only 0.4%.

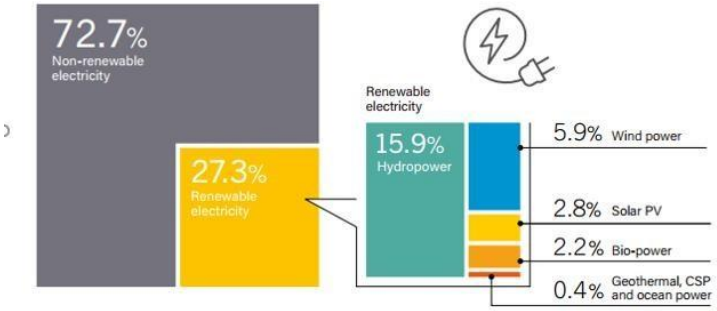
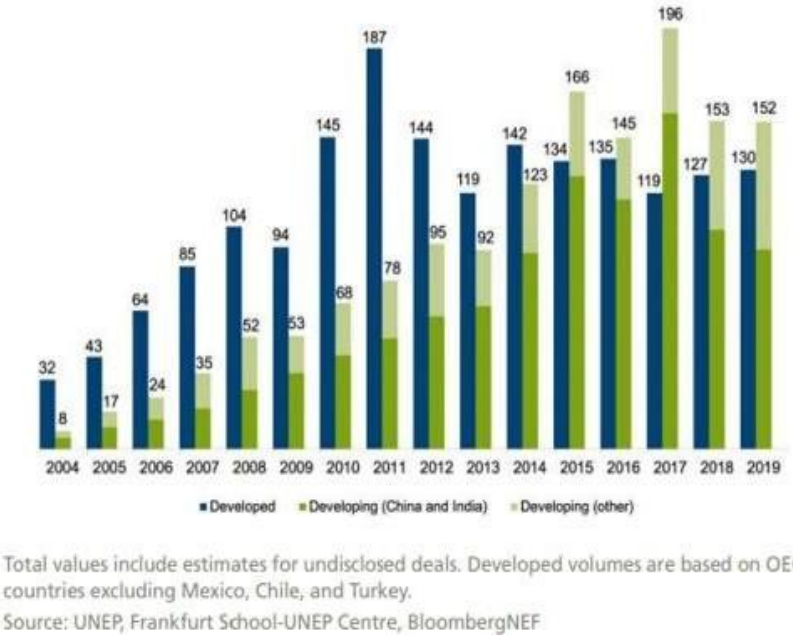


Fig. 2. Estimated Renewable Energy Share of Global Electricity Production, End 2019 [3]

According to the GSR, despite gains in energy efficiency and continued growth in EV sand bio-fuels, the transport sector has the lowest share of renewable energy. On the other hand, the renewable power sector has experienced record-high increases in capacity, outpacing net installations in nuclear power and fossil fuel [3].

In 2015, developing economies accounted for the preponderance of global investment in renewable energy capacity for the first time, and continue to do so. In 2019, $54 percent of the world's total of

$282.2 billion was represented by the United States. This was the same proportion as in 2018, but it was lower than the 62% share in 2017. It was the highest amount ever invested in renewable energy capacity in other developing countries outside of China and India. [4]



Total values include estimates for undisclosed deals. Developed volumes are based on OECD countries excluding Mexico, Chile, and Turkey.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

Fig. 3. Investment in renewable energy capacity, developed vs developing countries, 2004-2019 $BN [4]



Renewables figure excludes large hydro. Capacity and generation based on BloombergNEF totals.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

Fig. 4. Renewable Power Generation and Capacity as a Share of global power, 2007-2019, % [4]

GTREI is a report published annually by the Frankfurt School under the auspices of the UN Climate and sustainable energy finance group. It examines renewable investment in the context of the entire system of electricity generation [4]. As shown in Fig. 4, the addition of renewable energy generation capacity is progressively altering the global energy composition. The blue line indicates that, excluding

large hydro, renewables generated an estimated 13.4% of the world's electricity in 2019, up from 12.4% in 2018 and just 6.2% in 2010. The upper line represents the proportion of last year's net new generating capacity additions that consisted of wind, solar, and other renewable technologies. The performance of investments in renewable energy has been noticeably more impressive in recent years. As depicted in Fig. 4, a record increase of 78% was observed in 2019, setting a new benchmark.

Emerging Renewable and Sustainable Energy Technologies

There are two types of renewable energy technologies: mainstream and emerging. The primary renewable energy sources include geothermal, hydropower, biofuel, wind, sun, and biomass. Improved geothermal energy, marine energy, solar photovoltaics, cellulosic ethanol, and artificial photosynthesis are examples of emerging renewable energy sources. Many popular renewable energy technologies have been developed during the previous few decades, and within the past ten years, a number of innovative renewable energy technologies have arisen. Emergent renewable technologies are discussed in more detail in the sections that follow.

Ocean Power

Marine energy is another name for ocean energy. These seas contain enough energy in the form of heat, waves, currents, and tides to fulfill the world's energy demands [5], yet they account for the lowest share of the market for renewable energy [6].

Wave motion is the source of ocean power. The ships were identified by the floating beacon at the water's surface. The floating beacon pulls the wires below by moving up and down in response to changes in the water's surface. It features a generator coil with a magnet inside. An electric current is produced by the magnet's to-and-fro motion and is transmitted via wires.

The size of the worldwide ocean power market was estimated at $0.6 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 21.4% from 2022 to 2031, reaching $7.8 billion [40]. The shoreline serves as the basis for the scope. Higher power may be produced via longer coastlines. This technique aids in the production of power for the inhabitants of the islands along the shore.

The ocean power business has started to move toward semi-permanent installations and device arrays, despite slow progress in this area. Numerous regional government initiatives with a range of incentives have been put into place [7]. Ocean waves generate between 20,000 and 80,000 terawatt hours of power, according to the International Energy Agency.

Three countries joined the IEA Technology Collaboration Program on OES in 2001; by 2022, there were 22 member countries [8].

Table 2: List of OES members of 2022

Membersin 2022		
Australia	Belgium	Canada
China	Denmark	France
Germany	Ireland	India

Italy Mexico NewZealand Singapore United Kingdom	Republic of Korea	Japan
	Monaco	Netherlands
	Portugal	Spain
	Sweden	European Commission
	United States of America	

Wave and Tidal Energy

The wind is the sole energy source for maritime waves. The turbine rotates as a result of the air from the chamber moving in and out of it as the water level in the chamber rises and falls. Here, the generator transforms the mechanical energy into electrical energy. Because waves can absorb energy from the wind across large stretches of open water, they can transport energy with little loss. Because of the gravitational and rotational interactions between the moon, sun, and earth, tidal energy is produced by the rise and fall of ocean waves [10]. For a long time, tidal energy has been used for commercial purposes [1]. The idea behind this technology is similar to that of power plants acting as reservoirs, but instead of traveling downstream, the wave masses move back and forth in reaction to the tidal flow [11].

In 2022, the market for wave energy converters was valued at USD 21.08 million. The wave energy converter market is expected to develop at a pace of around 4.70% between 2022 and 2030. The wave energy converter market's major application area is power generation [41]. According to the World Energy Council,

Ten percent of the world's electrical needs might be satisfied by ocean energy. Wave energy comes from any body of water that creates waves and is a clean renewable energy source. All year round, the energy may be generated.

However, when the weather is bad, the wave force drastically decreases. The neighboring crab, fish, and plant ecosystems will be impacted by the massive equipment, which will also make a lot of noise. Large expenditures, large equipment, and manpower are the main drawbacks of this approach.

Concentrated Solar Power/Photovoltaics

One of the best ways to address the world's expanding energy needs is solar energy [12]. The photovoltaic cells capture sunlight. An electric field is produced by the positive and negative charges on the semiconductor wafer. The electric current is produced when the field's electrons are released due to solar energy. This technique is used to generate power from solar energy. The globe receives around four million exajoules (1 EJ = 1018J) of solar energy per year. 5X 104EJ are said to be harvestable [13].

The amount of solar flux that reaches the Earth's atmosphere is determined by latitude, climate, regional variance, and diurnal fluctuation [14]. The earth's atmosphere receives around 342 Wm-2 of solar energy, of which 70% may be retained and 30% is reflected into space [12]. Globally, effective solar energy production varies from 60 to 250 Wm-2 annually [15]. The potential of solar energy is vast. Solar energy is generated from roofs and solar plants in equatorial, tropical, and temperate climates. As a result, the solar panels had a high starting cost and needed constant sunshine.

Solar thermal technology and photovoltaic technology are the two types of active solar

energy technology [16]. The favored technique for converting solar energy into electrical energy has recently been the use of semiconductors [17]. Solar energy is used for heating, drying, and boiling in both residential and business settings [18]. However, in the industrial sector, CSP is utilized to produce power, whereas CST is used to satisfy similar demands [12].
Fig. 5 represents the classification of solar energy technologies.

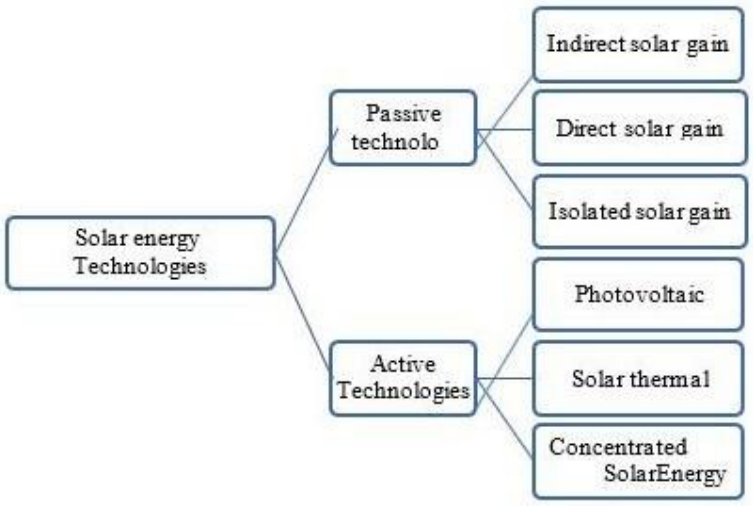


Fig. 5. Classification of solar energy technologies [12]

One of the drawbacks of this technology is the high cost of installation. A 6kW solar panel system for a 1500-square-foot residence typically costs $18,500 nationwide. The cost of a solar panel may vary from $2.50 to $3.50 per watt [19]. Furthermore, solar energy is not the most reliable source of energy since this technology can only be used on bright days, particularly when air pollution at the installation location reduces cell performance [20].
EGS
For a solar photovoltaic and wind-only hybrid grid to be implemented, it is essential to provide continuous renewable energy with thermal and geothermal energies since batteries are needed to store large quantities of energy.
EGS is expected to boost geothermal energy since hydraulic fracturing can provide geothermal fluid sources in the amount and quality needed in many regions where they are not naturally present [21]. The fluid was injected into the heated rocks using a man-made apparatus to produce electricity. Binary cycle, dry stream, and flash stream are the three primary technologies. In order to produce a fracture system, water is injected into the thermal reservoir at very high pressure to create the EGS system. Injecting water into the fracture system is the initial step. Conducting the water to the surface by intersecting the fracture system is the second phase.
In densely populated nations, enormous amounts of energy are needed. The high levels of greenhouse gas emissions in inhabited and polluted regions raise the temperature of the subsurface. These are selected in order to produce geothermal energy. from the paper on associated market research. The market for geothermal turbines was estimated to be worth $67.5 billion in 2021 and is expected to expand

at a compound annual growth rate (CAGR) of 4% from 2022 to 2031, reaching $99.5 billion.
The need for enormous amounts of water for ongoing hydraulic fracturing activities limits this energy. Furthermore, this technology is expensive, dangerous, and complicated [22].

Cellulosic Ethanol
Sugarcane and maize starch are used to make cellulosic ethanol. To get enzymes, the fibers were first pre-treated using a variety of methods. They are then hydrolyzed to produce cellulase, a fermented sugar. then used yeast for further fermentation to create ethanol [42].
In terms of volume, ethanol is the biggest liquid biofuel [23]. The United States and Brazil are the world's top producers of gasoline ethanol, as Fig. 6 [24] illustrates.

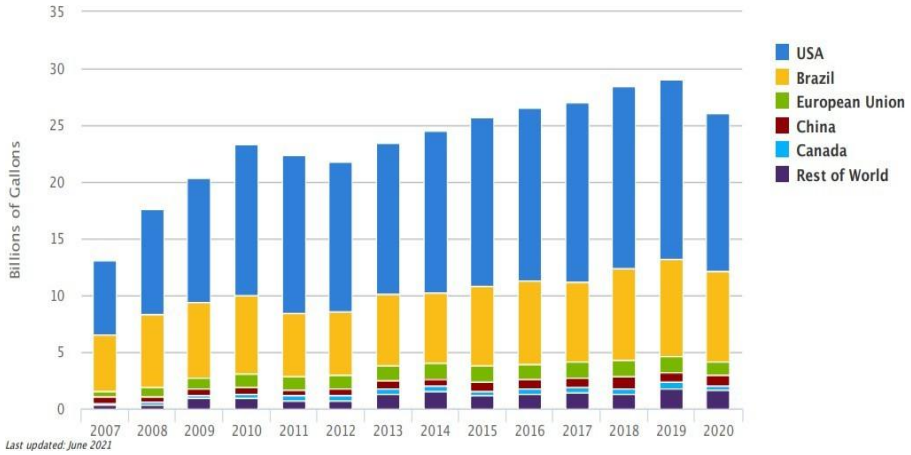


Fig. 6. Global Ethanol Production by Country or Region [24]

In 2020, the United States used $12.6 billion worth of cellulosic ethanol. It is comparable to around 40% of the increases in real income that the US would experience if all import restrictions were removed [43]. Ligno cellulosic biomass, which is distributed on the ground and has low mass and energy densities for large quantities and high transportation costs, is a sustainable feedstock for the generation of fuel ethanol [23].
Cellobiose is the repeating unit of cellulose, a homogenous glucan with variable DP made up of -1,4 glycosidic linkages [25]. Although the process of producing cellulosic ethanol is complex, a University of California, Berkley research found that this energy might cut greenhouse gas emissions by 90%.
The decrease of steps in the cellulosic ethanol formulation by expanding process integration is one of the many challenges that researchers in the area of cellulosic ethanol must face in order to commercialize this technology [44].

Artificial Photosynthesis
The main renewable energy source is the sun. One use for it with water is artificial

photosynthesis. There are three stages. Chlorophyll harvests light in the first stage, tyrosine mediates electron mobility to function as a catalyst in the second, and manganese sends electrons to chlorophyll in the last phase [26].
The electron transport mechanism of artificial photosynthesis is the same as that of natural photosynthesis, to sum up the idea [26].
This energy might be used to efficiently create solar fuels in the future. Its important contracts are its catalytic phases. Although there are a number of laboratory prototypes of devices that split water into hydrogen using sunlight, there are safety issues with hydrogen storage and delivery. Furthermore, AP materials are often immersed in water, which might lead to stability problems.
On an industrial scale, artificial photosynthesis has a lot of potential. Global warming can be stopped by it. It produces no byproducts and is a clean renewable energy source. Solar fuel is used to store the energy generated during the process for later use. This makes it possible to develop new cars that emit no carbon dioxide. Finding the ideal transition metal catalyst to balance stability, selectivity, and activity for each intended reaction is difficult, however.

Applications

In order to construct green cities, we employ these renewable energy in our everyday lives to power homes, buildings, and cars. As shown in Fig. 7, photovoltaics and wind energy will be used in our work to mimic an electric car charging station. Initially, the wind turbines and solar panels provide the DC. MPPT received electrical energy from the solar panel and transferred the maximum power from the solar cells. To determine the ideal value, the voltage and current were tracked. A DC-DC converter may be used to change the voltage if it varies. Energy is transferred from the source to its EVs via the DC Microgrid. The current is converted at the receiving end using a DC-AC converter. The LC filter enhances the electrical signal's waveform quality and eliminates undesired noise from the circuit.
The wind turbine is linked to DC-DC converters, and MPPT, the charge controller, monitors the electric current. A bidirectional DC-DC converter was used to simultaneously charge and discharge the battery bank from the DC microgrid.

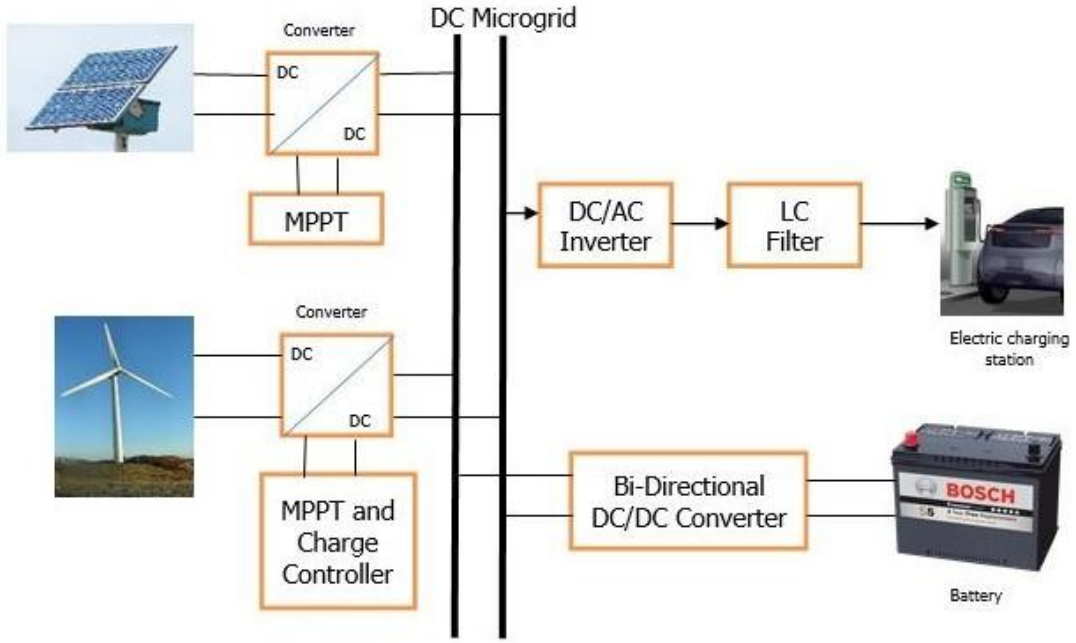


Fig. 7. Diagram for Charging station using renewable energies

Advantages and Disadvantages of Charging Station

Advantages

EV Charging stations will reduce carbon footprints and reduce air pollution.
It helps to change the electric vehicles at own convince.
Renewable energy such as solar and wind helps to reduce the non-renewable energy in the charging station.
Reduce greenhouse gases.
Eco-friendly method

Disadvantage

It required an initial investment for the setup.
It takes more time to charge the battery.

Result and Discussion

The method, scope, market share, and problems of marine energy, concentrated solar photovoltaics, EGE, cellulosic ethanol, and artificial photosynthesis have all been described. It demonstrates that the world's future lay in renewable energy. The non-renewable energy source is in danger of being extinct. For many nations, renewable energy was their only option. Although the initial cost of renewable technology may be high, they have a ten-year lifespan. We can get more energy than non-renewable energy in an environmentally responsible way by combining all of the renewable energy sources. Every nation must assess its renewable energy resources and make investments for the country's and its citizens' future growth. In order to minimize labor, equipment, and investment, the project has to be expanded with more study. Higher and more effective energy output results from this. Utilizing wind and solar energy, the application helps to provide power all day long. Wind energy is generated more at night, whereas solar energy is used during the day. This offers outstanding performance in a variety of operating scenarios. Because the battery can store extra renewable energy

during times of low demand and provide at times of high demand, it may improve system dependability.

Comparison of Investment and Efficiency of Non-Renewable Energy and Renewable Energy

Exploration, extraction, infrastructure, manpower, machinery, and a large amount of land were all necessary for the development of any power plant, whether renewable and non-renewable. In addition to the original investment, there are continuing expenses for fuel acquisition, maintenance, mining, and refining. All sources often need a larger initial expenditure, which may be reduced over time as a result of economies of scale and technical advancements. The majority of the sources are free, however in order to get the energy, we require a greater initial per capita cost and relatively low operating costs.

In terms of energy density and conversion rates, the efficiency of any source is comparatively high. The development of technology determines the efficiency. The process of turning the source into power will be more efficient. However, when it inherits losses from the extraction, shipping, and conversion processes, the efficiency drops. When compared to non-renewable energy, renewable energy has a lower energy density. This means that in order to produce the same quantity of energy from non-renewable sources, renewable energy must supply more comprehensive infrastructure across broad regions.

The particular project (small-scale or large-scale), resources, location, and technical innovation all affect how much a power plant costs. Therefore, we are unable to forecast any energy source's significant investment. On the other hand, power plant investments are estimated. The investment in an ocean power plant might be anything from $3 million to $300 million. The efficiency of ocean power plants ranges from 20% to 40%, depending on the project. at a tidal power facility. The efficiency ranges from 35% to 45%, with investments ranging from $3 million to $20 million. The efficiency of a geothermal power plant is from 10% to 20%, and the investment is between $2 million and $5 million. The cost of a solar power plant ranges from $1000 to $300 per kilowatt, depending on its size, and its efficiency ranges from 20% to 25%. The cost of cellulosic ethanol ranges from $200 million to $500 million, with an efficiency of 40% to 50%. The artificial photosynthesis power plant is still in its early stages of development, and the estimated cost has not yet been determined. The efficiency of the coal power plant is based on 30% to 40%, and the investment is between $1 million and $5 million. The efficiency of an oil power plant is between 25% and 40%, and the expenditure ranges from millions to billions. The natural gas plant has an efficiency of 50% to 60% and an investment of between $0.5 million and $2 million. The cost of a nuclear power plant ranges from $1 to $10 billion, and its efficiency is more than 30%. Figures 8 and 9 compare non-renewable energy sources including coal, oil, natural gas, and nuclear energy with renewable resources like ocean energy, tidal energy, geothermal energy, solar energy, and cellulosic ethanol. In this case, the maximum energy and investment are taken into account.

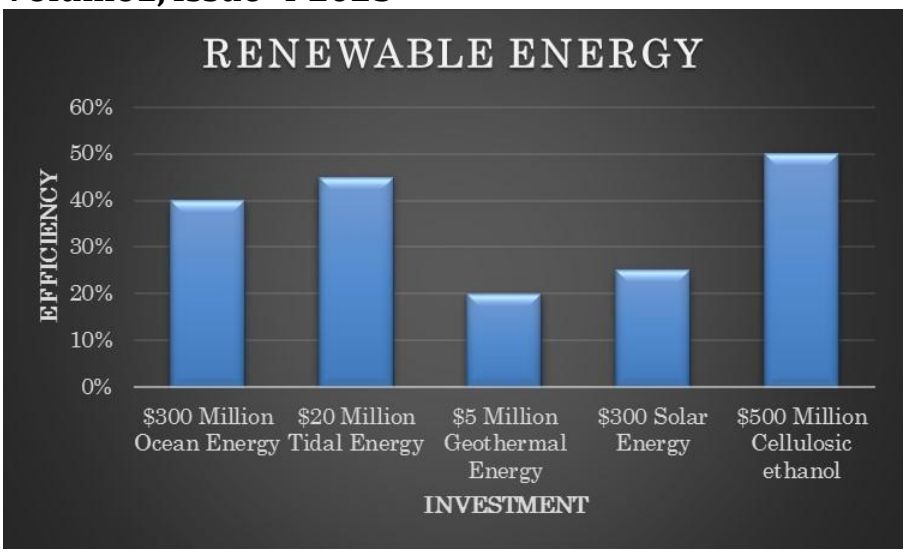


Fig. 8. Comparison of Investment vs Efficiency for renewable energy

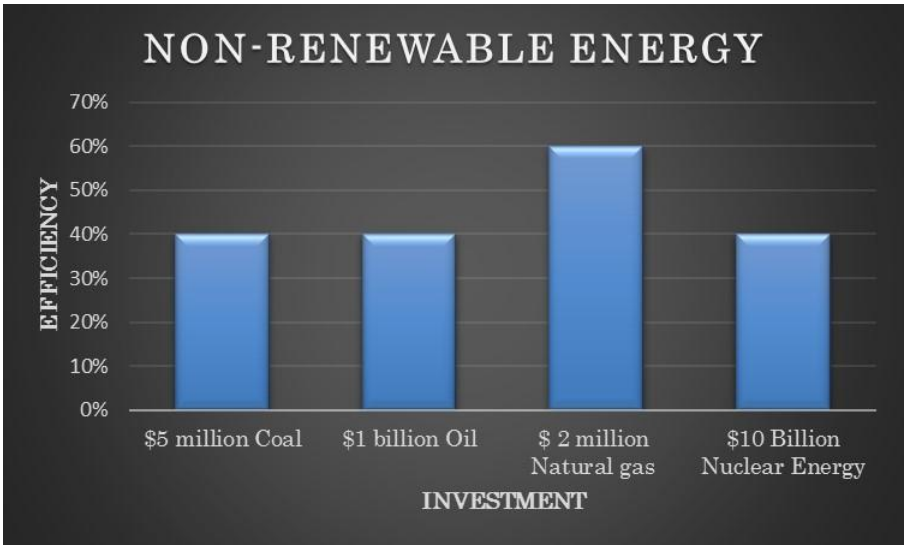


Fig. 9. Comparison of Investment vs Efficiency for non-renewable energy

According to the graph, non-renewable energy sources have traditionally been more affordable because of their high energy density and well-established infrastructure, despite the initial large investment. But the expenses of non-renewable energy go beyond just money. Renewable energy technologies are getting more affordable as they develop and economies of scale are achieved. The cost of solar and wind energy has dropped dramatically in recent years, making them comparable or even less expensive than fossil fuels in many areas. Furthermore, compared to non-renewable energy sources, renewable energy sources have the benefit of being sustainable and having a far less environmental effect.

Conclusion

New directions in renewable resource research were made possible by the expanding population, rising greenhouse gas emissions, and depletion of non-renewable resources.

The goal of this research is to comprehend new methods for extracting renewable energy and their uses. The planned research is beneficial for the efficient use of renewable resources to lower greenhouse gas emissions. Within each of the key emerging technologies, there are several sub-technologies. To clean up the environment, we must encourage these renewable technology. Furthermore, renewable energy sources are catching up in terms of cost-effectiveness and efficiency, while non-renewable energy sources have historically been quite efficient and needed large investment. The continuous worldwide transition towards
Long-term sustainability, environmental concerns, and declining prices are some of the driving forces behind renewable energy.
These renewable energies may be used in electric vehicle (EV) recharging stations since Morocco consumes a lot of electricity.

Compliance with Ethical Standards

Conflicts of interest: The writers said that they don't have any.
Human subjects: The study was carried out in accordance with ethical guidelines, and the authors made sure that neither human subjects nor animals were used in any of the experiments.

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